

termed by Dr. Mivart the "Ursine Lozenge." Dr. Mivart has justly laid stress upon the prevalence of this definite area in the Arctoid brain. He defines the Arctoid brain by the presence of the "Ursine Lozenge." The "Ursine Lozenge" of *Gulo* is most like that of *Galictis* among the types which I have examined, thus confirming the justice of its placing by Dr. Mivart¹ and others. The brains of these two animals are intermediate in character between those of *Nasua*, *Ictonyx*, and *Mustela* on the one hand, and those of *Helictis*, *Meles*, and *Mellivora* on the other. In the former group the lozenge is absent owing to the absence of a precrucial sulcus. I found traces of it in *Nasua*, which genus, it will be remembered, approaches *Galictis* in the presence of a post-crucial bridging convolution between the hippocampal and sagittal gyri.

Both Prof. Garrod² and Dr. Mivart were, in my opinion, wrong in regarding the brain of *Helictis*, first described by the former, as "exceptional." In *Meles taxus* we meet with precisely the same appearance of the hippocampal gyrus upon the upper surface of the brain. In these animals and, according to Mivart, in *Mellivora* there is an ursine lozenge formed which is completely closed in front. These therefore form the extreme term in a series which commences with the simpler brain of *Ictonyx*.

2. On the Brain in the Lemurs. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

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During the last few years I have accumulated a number of well-preserved Lemurs' brains extracted from specimens that have died in the Society's Gardens. I have thought that it might be useful to publish an illustrated account of some of these in order to supplement the existing knowledge of the Lemurine brain. The brains that I have examined myself are the following:—

<i>Lemur mongoz</i> ,	<i>Galago crassicaudatus</i> ,
<i>Lemur brunneus</i> ,	<i>Galago monteiri</i> ,
<i>Lemur anjuanensis</i> ,	<i>Cheirogaleus coquereli</i> ,
<i>Lemur coronatus</i> ,	<i>Loris gracilis</i> ,
<i>Lemur albifrons</i> ,	<i>Nycticebus tardigradus</i> ,
<i>Lemur rufipes</i> ,	<i>Perodicticus potto</i> ,

besides *Hapalemur griseus*, of whose brain I have recently published a description³.

The literature referring to the Lemurine brain is not great.

¹ "On the Anatomy, Classification, and Distribution of the Arctoidea," P. Z. S. 1885, p. 240.

² "Notes on the Anatomy of *Helictis subaurantiaca*," P. Z. S. 1879, p. 305.

³ "Additional Notes upon *Hapalemur griseus*," P. Z. S. 1891, p. 456.

Nycticebus has been described and figured by Sir William Flower¹ and compared with *Lemur nigrifrons*. Burmeister² has dealt with the brain of *Tarsius* and given a figure thereof. Van der Hoeven and van Camper³ have described but not figured the brain of the Potto. Owen has given⁴ an illustrated account of the brain of *Chironomys*. Finally Milne-Edwards⁵ has published figures and descriptions of the brain in *Avahis laniger* and other Indrisinæ; and Gervais⁶ has written a more comprehensive paper than any of these, but his drawings are all from intra-cranial casts.

§ *The Brain of Lemur.*

Having had so many different species of *Lemur* for examination, I am able to say something as to the range of variation in the convolutions of this genus. This range is not large, but the bigger brains are on the whole more complex than the smaller. *Lemur anjuanensis* has the simplest brain of all the species I have examined. It is almost precisely like *L. nigrifrons* figured by Flower. In *Lemur albifrons* the *angular* and *infero-frontal* sulci very nearly join; on the lateral aspect of the brain two small sulci are visible, which are represented by the merest traces in *Lemur anjuanensis*; the first of these is in front of the Sylvian fissure, and runs obliquely upwards at right angles to the infero-frontal sulcus. The other fissure is a commencing division of the medio-temporal gyrus.

In *Lemur rufipes* the angular and infero-frontal fissures do not join; in the middle of the widest portion of what may perhaps be termed the sagittal gyrus is a deep, but very short furrow on each side. In this brain, as in those of all the species of the genus *Lemur*, the angular fissure has the form of an elongated S. The small perpendicular presylvian fissure has another in front of it. There are the same indications as in *Lemur albifrons* of a division of the medio-temporal lobe. *Lemur brunneus* hardly differs. On one side of the brain, however, there was a very considerable furrow half an inch long, dividing the upper part of the medio-temporal lobe.

In the brain of *Lemur mongoz* the angular and infero-frontal sulci are completely continuous. Otherwise there are no special points to be noted. Of *Lemur coronatus* I have examined two brains from two individuals, which, though of different sizes, were both females. In neither were the angular and infero-frontal sulci continuous. Both presylvian fissures were present, at least in the larger brain.

¹ "On the Brain of the Javan Loris," Tr. Z. S. vol. v. p. 103.

² 'Beiträge zur näheren Kenntniss der Gattung *Tarsius*,' 1846.

³ 'Ontleedkundig Onderzoek van den Potto van Bosman.'

⁴ "On the Aye-aye," Tr. Z. S. vol. v. p. 68. See also Oudemans, Nat. Verh. Akad. Amsterdam, xxvii.

⁵ Hist. Nat. de Madagascar, Mamm. p. 193.

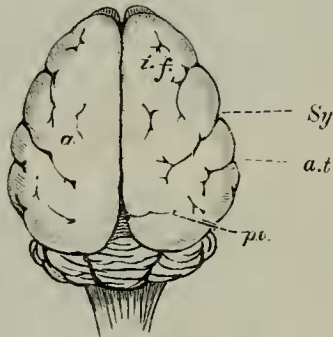
⁶ "Mémoire sur les formes cérébrales propres à l'ordre des Lémures," J. Zool. i. p. 1.

§ *The Brain of Nycticebus tardigradus.* (Fig. 1.)

There appear to be more differences between the brain of this animal and that of its congener *Nycticebus javanicus* than between the different species of *Lemur* that I have examined.

To begin with, the brain is more rounded in front and the cerebellum is more fully exposed than is indicated in Sir W. Flower's figure¹ of *N. javanicus*. The angular fissure (*a*) is short, but instead of being straight it is crescentic in outline, the concavities facing each other. The two fissures look like a pair of brackets. The infero-frontal suture (*i.f.*) seems to be less conspicuous than in the other species of the genus, and on one side of the brain it ran back to join the curved (anteriorly convex) presylvian fissure, the homologue (?) of which latter in *N. javanicus* has a totally different direction. The parieto-occipital ("Simian") (*p.o.*) fissures are better developed than in *N. javanicus* and reach the intercerebral sulcus.

Fig. 1.



Brain of *Nycticebus tardigradus*.

a, angular fissure; *i.f.*, infero-frontal; *Sy.*, Sylvian fissure; *a.t.*, antero-temporal; *p.o.*, parieto-occipital.

§ *The Brain of Perodicticus potto.* (Fig. 2, p. 145.)

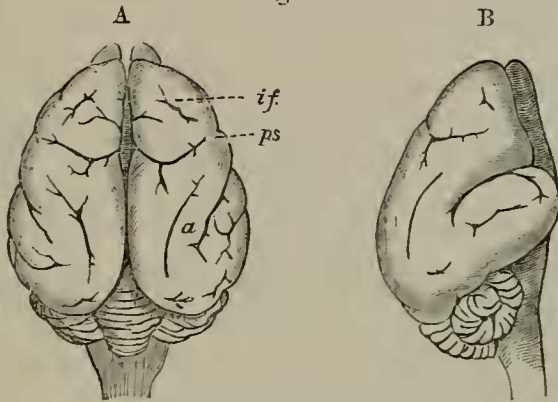
This brain differs from that of *Nycticebus*. The angular fissure (*a*) begins further back, well behind the extremities of the Sylvian and antero-temporal fissures, which are curved outwards as in the genus *Lemur*, but have not the peculiar S-shaped form that they have in that genus. The infero-frontal sutures, if I am right in so identifying those lettered *i.f.* in the drawing (fig. 2), have not the longitudinal direction that they have in other Lemurs. They run almost at right angles to the longitudinal axis of the brain, and are apparently very like those of *Callithrix* as figured by Sir Wm. Flower². The angular fissure is prevented from joining the infero-frontal by a long straight presylvian fissure (*p.s.*), which runs up between them. The antero-temporal and Sylvian fissures

¹ *Loc. cit.* pl. 27. fig. 1.

² *Loc. cit.* pl. 27. fig. 11.

join or nearly join above. There are faintly marked parieto-occipital fissures.

Fig. 2.

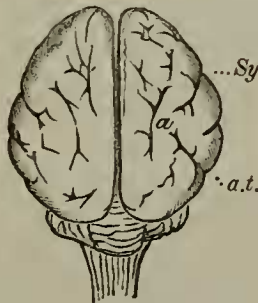
Brain of *Perodicticus potto*.

A, dorsal, B, ventral aspect; *p.s.*, presylvian fissure; other lettering as in fig. 1.

§ *The Brain of Loris gracilis.* (Fig. 3.)

The description of this little brain will not detain us long, as it is, with the exception of *Cheirogaleus*, the simplest form of Lemur's brain known to me. It is very rounded in form, a character which also distinguishes *Cheirogaleus*.

Fig. 3.

Brain of *Loris gracilis*.

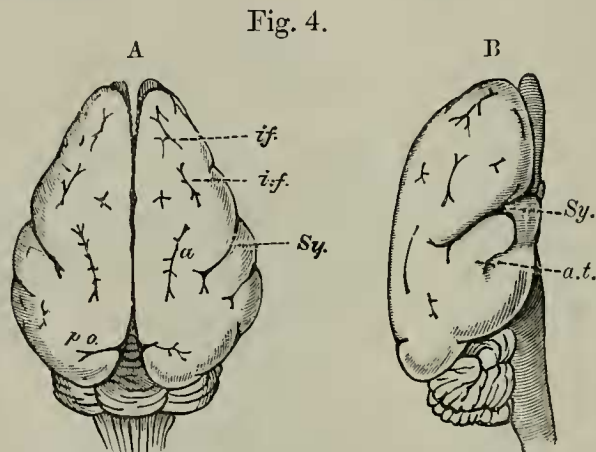
Lettering as in fig. 1.

There are only three fissures plainly visible—the Sylvian, the angular, and the antero-temporal. The angular fissure is of moderate dimensions and is curved, the concavity being outwards. The other fissures call for no particular comment. On one side of the brain of one of the two specimens which I have is a very short parieto-occipital fissure. I would point out, in criticism of the use of intra-cranial casts, how totally my figure differs from

that of Gervais¹, who represents the brain of this animal as comparatively complicated. As I have examined two brains which agree with each other, I think it may be fairly assumed that my description is accurate.

§ *The Brain of Galago crassicaudatus.* (Fig. 4.)

The brain of this Lemur differs in several particulars from the brains of other Lemurs which I have examined, though it is constructed upon the same general plan. The general outline of the brain is much as in the genus *Lemur*. The fissures are, on the whole, few, when the size of the brain is taken into consideration, but some of them are very deeply engraved. This is the case with the Sylvian and angular fissures, which are really the only well-marked ones.



Brain of *Galago crassicaudatus*. A, front, B, side view.

Lettering as in fig. 1.

The Sylvian fissure is not quite so long as it is in some other Lemurs. The angular fissure is not more than a quarter of an inch long, but it is very deep; it is slightly crescentic, the concavity embracing the extremity of the Sylvian fissure. The infero-frontal fissure on each side is represented by two detached portions, which are very short but fairly deep. They are in the same straight line, and the direction is obliquely inwards as in the genus *Lemur*. There is a small dent in the brain-substance just on a level with the hindermost extremity of the infero-frontal sulcus, in the middle of the widest part of the sagittal gyrus, which appears to correspond to a more strongly marked impression that I have already referred to as existing in a similar position in the genus *Lemur*. Below the infero-frontal sulci is a rather faintly marked furrow, longitudinal in direction, which I compare

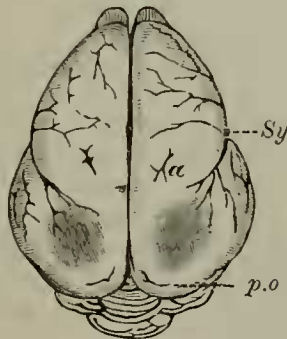
¹ *Loc. cit.* fig. 2, pl. ii.

with the anterior of the two presylvian sulci found in many Lemurs. A very curious thing about the brain of *Galago* is the very faintly marked antero-temporal furrow. This is so characteristic a fissure of the Lemurine brain, and is the only fissure besides the Sylvian which is found in the otherwise smooth brain of *Tarsius* according to Burmeister's figures. We shall see, however, that it is also absent in *Cheirogaleus*. The parieto-occipital fissure is represented by two small grooves starting from the middle line. The brain of *G. monteiri* is not very different, but the dent lying in front of the angular sulcus is absent.

§ *The Brain of Cheirogaleus coquereli.* (Fig. 5.)

This brain, as already mentioned, has a rounded form comparable to that of *Loris gracilis*, but it is much flatter, in fact markedly flat. On the upper surface, behind the Sylvian fissure, is a curious hollowing of the brain-surface, which is unlike anything that I have seen in any other Lemur. The cerebral hemispheres diverge from each other very slightly behind, the posterior margin of the hemispheres being almost straight.

Fig. 5.



Brain of *Cheirogaleus coquereli*.

Lettering as in fig. 1.

The brain is very slightly furrowed, not nearly so much even as in *Loris gracilis*, which is, moreover, a smaller brain. The only sulcus which is really conspicuous is the Sylvian. There is, as already mentioned, practically no trace of the antero-temporal. The angular fissures are, however, feebly represented by two short, shallow sulci, not more than $\frac{1}{8}$ th of an inch in length. They are just in the middle of the brain.

§ *Mutual Affinities of the Genera of Lemuroidea as indicated by Brain-structure.*

There is no doubt that the structure of the brain of the Aye-aye, as figured by Owen, justifies the placing of that genus in a

family by itself. Its most marked characters are (1) the production of a large semicircular sulcus by the fusion of the Sylvian with the parieto-occipital fissures¹: (2) the length of the angular sulcus which blends in front with the infero-frontal and gives off two branches, one running downwards parallel with the Sylvian fissure, the other running inwards towards the middle line². The former character is the most distinctive; for the long angular sulcus fused with the infero-frontal is met with in the *Lemurinae*, and there are in them and in other Lemurs traces of the two branches in the presylvian fissure, and in the indentation to which I have referred as lying in the widest part of the sagittal gyrus. As to *Tursius*, it has so smooth a brain that no inferences can be drawn.

There remains the family Lemuridæ, of which four subfamilies are commonly allowed, viz., *Lemurinae*, *Indrisinae*, *Galagininæ*, and *Lorisinae*.

The first mentioned subfamily has a very uniform type of brain-structure. The differences between *Hapalemur* and *Lemur*, which I indicated some years since, are removed by the examination of a larger series of brains of Lemur. Indeed the only difference which I thought myself justified in pointing out was the continuity in *Hapalemur* of the angular and infero-frontal fissures; but, as I have mentioned in the present paper, the continuity is more marked in *Lemur mongoz*.

The *Lorisinae*, on the other hand, do not form so natural an assemblage as do the *Lemurinae*. It seems as if we had in this group the few remnants of a formerly much larger series—a suggestion which is borne out by their wide and scattered distribution. They all, however, agree to differ from the *Lemurinae* in the shortness or even rudimentary character of the angular and infero-frontal fissures, which do not nearly meet, and in the presence of the parieto-occipital fissure near the middle line of the brain. These remarks, of course, hardly apply to the small and smooth brain of *Loris*.

The *Galagininæ* have as their most distinctive character the absence or feeble development of the antero-temporal fissure. They seem to be most like the *Lorisinae* in other characters. They resemble them in the shortness of the angular fissure, and *Galago* has a further point of likeness to *Perodicticus* and *Nycticebus* in the cross-like parieto-occipital structure.

In all the *Indrisinae* figured by Milne-Edwards this last mentioned fissure is well marked. But as I have not examined the brains of any of this group, I do not venture upon the expression of any opinion as to their affinities.

¹ They are separated according to Oudemans.

² Or nearly; see Oudemans, *loc. cit.* pl. iii. figs. 12, 14.